Cm

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/582,903	08/11/2000	KENJI KATO	S004-4034PCT	3167

7590 06/07/2004

BRUCE L ADAMS
ADAMS & WILKS
50 BROADWAY
31ST FLOOR
NEW YORK, NY 10004

EXAMINER	
CHU, KIM KWOK	

ART UNIT	PAPER NUMBER
2653	6

DATE MAILED: 06/07/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No. 09/582,903	Applicant(s) KATO ET AL.	
	Examiner Kim-Kwok CHU	Art Unit 2653	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *Amendment filed on 7/16/01 (paper 5)*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-119* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *98,107,109 and 110* is/are allowed.

6)☒ Claim(s) *1-3,6-34,36,37,39-42,44-66,68-74,76-82,84-97,99-106,108 and 111-119* is/are rejected.

7)☒ Claim(s) *4, 5,35,38,43,67,75 and 83* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. PCT/JP99/06150.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Claim Objections

1. Claims 66 and 106 are objected to because of the following informalities:

(a) in claim 66, last line, the term "planed single crystal silicon" should be changed to --planed with single crystal silicon--; and

(b) in claim 106, line 13, the term "and UV-set same to thereby form a convex form;" does not read right.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> *A person shall be entitled to a patent unless --*
> *(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.*

3. Claims 1, 2, 3, 6-9 and 11-14 are rejected under 35 U.S.C. § 102(b) as being anticipated by Ohta et al. (U.S. Patent 5,294,790).

Ohta teaches a near-field optical head having all the elements and means as cited in claims 1, 2, 3 and 6-9. For example, Ohta teaches the following:

(a) as in claim 1, a planar (flat) substrate 101 having a first surface, a second surface disposed opposite to the first surface (Fig. 2);

(b) as in claim 1, an inverted conical hole 102 extending through the first and second surfaces and having at least one fine aperture 110 formed at an apex and disposed on the first surface (Fig. 2; aperture means 108 is formed on the hole 102);

(c) as in claim 1, an optical waveguide 103 disposed on the second surface of the planar substrate 101 for propagating light (Fig. 2);

(d) as in claim 1, a light reflection film 105 disposed in the optical waveguide for reflecting in the direction of the fine aperture light propagated through the optical waveguide (Fig. 2; clad 105 is light reflective);

(e) as in claim 2, the optical waveguide 103 is disposed inside of the inverted conical hole 102 (Fig. 2);

(f) as in claim 3, the inverted conical hole 102 comprises a plurality of slant surfaces each having a different degree of slant from the other (Fig. 9e);

(g) as in claim 6, the inverted conical hole 102 of the planar substrate has at least one curved slant surface (Fig. 2);

(h) as in claim 7, the curved slant surface decreases in slant degree toward the fine aperture (Fig. 2);

(i) as in claim 8, the optical waveguide 103 focuses light to the fine aperture 110 (Fig. 2); and

(j) as in claim 9, the optical waveguide comprises a core 104 and a clad 105 disposed over the core (Fig. 2).

4. Method claims 11-14 are drawn to the method of using the corresponding apparatus claimed in claim 1. Therefore method claims 11-15 correspond to apparatus claim 1 and are rejected for the same reasons of anticipation as used above.

5. Claims 20-27, 115, 116 and 117-119 are rejected under 35 U.S.C. § 102(b) as being anticipated by Ohta et al. (U.S. Patent 5,294,790).

Ohta teaches a near-field optical head having all the elements and means as cited in claims 20-25, 115, 116 and 117-119. For example, Ohta teaches the following:

(a) as in claim 20, a planar substrate 101 having a first surface, a second surface disposed opposite the first surface (Figs. 1 and 2);

(b) as in claim 20, an inverted conical hole 102 extending through the first and second surfaces and having a fine aperture 110 formed at an apex and disposed on the first surface (Figs. 1 and 2; column 4, lines 24-50);

(c) as in claim 20, an optical waveguide 103 disposed on the second surface of the planner substrate 101 and on an inner surface of the inverted conical hole 102 (Fig. 2);

(d) as in claim 20, the optical waveguide 103 having a sharpened microscopic tip 108 protruding from the fine aperture of the inverted conical hole (Fig. 2);

(e) as in claim 21, a light reflection layer 105 for reflecting light is formed on a periphery of the optical waveguide except for the sharpened microscopic tip (Fig. 2; the core and cladding materials exhibit differing indices of refraction in order to achieve the internal reflection);

(f) as in claim 22, the sharpened microscopic tip 108 has a generally square pyramid shape (Fig. 40; the tip includes a square pyramid base);

(g) as in claims 23, 115 and 116, the inverted conical hole has a plurality of slant surfaces each having a different degree of slant from the others (Fig. 40);

(h) as in claims 24 and 117-119, the optical waveguide 103 is formed by a core 104 and a clad 105 (Fig. 2); and

(i) as in claim 25, the planar substrate has a plurality of very small apertures, and the optical waveguide and the light reflection layer being formed to guide light emitted from at least one light source toward the plurality of very small apertures (Fig. 32).

6. Claims 26 and 27 have limitations similar to those treated in the above rejection, and are met by the reference as discussed above and therefore rejected for the same reasons of anticipation as used above.

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> *A person shall be entitled to a patent unless --*
> *(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by applicant for patent*

8. Claims 28-30 are rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a near-field optical head having all the elements and means as cited in claims 28-30. For example, Muramatsu teaches the following:

(a) as in claim 28, an optical waveguide comprised of a first clad 2a having at least one inverted pyramidal hole 6 extending through there and having a fine aperture at an apex (Figs. 2e, 2f and 2g);

(b) as in claim 28, a core 8 extending along a side surface of the inverted hole (Figs. 2e, 2f and 2g);

(c) as in claim 28, a second clad 2 disposed over the core 8 so that the core is disposed between the first and second clads (Figs. 2e, 2f and 2g);

(d) as in claim 28, a first reflection film 30 disposed on an end surface of the optical waveguide (Fig. 2f); and

(e) as in claim 29, a second reflection film 23 disposed on a rear surface of the first clad 2a and having a microscopic diameter hole disposed in a position corresponding to the fine aperture (Fig. 8d); and

(f) as in claim 30, the end surface of the optical waveguide is curved (Figs. 2e and 2f).

9. Claims 31 and 32 are rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a near-field optical head having all the elements and means as cited in claim 31. For example, Muramatsu teaches the following:

(a) as in claim 31, an optical waveguide 2a comprised of a clad having at least one inverted conical hole 6 extending through the waveguide and having a fine aperture at an apex; (Figs. 2e, 2f and 2g; clad is an inherent feature of the waveguide 21 so that light does not leak or interferes from outside);

(b) as in claim 31, a core 8a extending along a side surface of the inverted conical hole (Figs. 2e, 2f and 2g);

(c) as in claim 31, a reflection film 30 disposed on an end surface of the optical waveguide 2a (Fig. 2f); and

(d) as in claim 31, a substrate 2 bonded on the core 8a of the optical waveguide and having a refractivity different from that of the core 8a (Fig. 2f).

10. Method claim 32 is drawn to the method of using the corresponding apparatus claimed in claim 31. Therefore method claim 32 corresponds to apparatus claim 31 and is rejected for the same reasons of anticipation as used above.

11. Claims 33, 36, 37, 39-42, 44-49, 51, 52, 60-66, 68-74, 76-82, 84-95 and 114 are rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a near-field optical head having all the elements and means as cited in claims 33, 36, 37, 39-42, 44-49, 51, 52, 60-66, 68-74, 76-82, 84-95 and 114. For example, Muramatsu teaches the following:

(a) as in claim 33, the near field optical head for recording and reading-out information 23 by utilizing near field light produced from a very small aperture 6 (Figs. 2e and 11; column 1, lines 19-23);

(b) as in claim 33, a very small aperture 6 formed at an apex of a taper formed by an optical propagation member 2a having a tip sharpened toward a recording medium (Fig. 2e; 2a is the tip/probe);

(c) as in claim 33, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Figs. 2e; column 1, lines 13-15);

(d) as in claim 33, a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 3a-3e; column 4, lines 18 and 19);

(e) as in claim 36, the taper 2a has a curved surfaced taper in at least one part (Fig. 8d);

(f) as in claim 37, the curved surfaced taper increases in angle of spread in the vicinity of the very small aperture as the aperture is approached (Fig. 8d; the cured tip increases its angle of spend upward);

(g) as in claim 39, the light propagation member 8 in at least one part is of dielectric (Fig. 2e; fiber optic 8 is a dielectric material such as glass);

(h) as in clam 40, the light propagation member 8 in at least one part is of air (Fig. 2e; apex of the waveguide/fiber optic 8 includes air as a light propagating path);

(i) as in claim 41, the taper in at least one part is covered by metal 23 (Fig. 8d; metal 23 is for reflecting a light beam);

(j) as in claim 42, the taper in at least one part is covered by dielectric (Fig. 2e; the taper/tip is made of glass);

(k) as in claim 44, a protrusion protruded from the very small aperture (Fig. 2b; the protrusion is the very top part of the taper);

(l) as in claim 45, the protrusion in at least one part is dielectric (Fig. 2b; the taper is made of glass);

(m) as in claim 46, the protrusion in at least one part is covered by metal 23 (Fig. 8d; metal layer 23 is for light reflection/focusing);

(n) as in claim 47, the protrusion is in a conical or pyramidal form (Fig. 2f);

(o) as in claim 48, a relative position to the recording medium is kept constant by a floating force undergone from a side of the recording medium and a load weight applied toward the recording medium (Fig. 11; column 6, lines 54 and 55);

(p) as in claim 49, the floating force is an air pressure caused due to high speed motion of the recording medium (Fig. 7; column 7, lines 1-3; a flying head floats on a layer of air);

(q) as in claim 51, a relative position to the recording medium is kept constant by controlling an electric interaction caused with the recording medium (Fig. 11; column 6, lines 54-63);

(r) as in claim 52, a relative position to the recording medium is kept constant by controlling an inter-atomic force interaction caused with the recording medium (Fig. 11; column 6, lines 54-63);

(s) as in claim 60, the light reflection layer in at least one part is metal 10 (Fig. 3d; column 4, lines 18 and 19);

(t) as in claim 61, the light reflection layer has a focusing function to focus the light reflected toward the very

small aperture (Fig. 2e; the taper 6 has a tip coated with a reflective layer 10 and 23 which act as a focusing device);

(u) as in claim 62, the light reflection layer has a light reflecting surface 23 in a concave surface (Fig. 8d);

(v) as in claim 63, the light reflection layer 10 has a light reflecting surface 30 having a grating structure (Fig. 2f);

(w) as in claim 64, the light reflection layer 10 is formed by working one part of the light introducing part 8 and laying on a worked surface (Fig. 3a-3e; column 4, lines 18 and 19);

(x) as in claim 65, the light reflection layer 10/23 is formed by laying on a slant surface formed at a constant angle as determined by a planar orientation due to chemical etching (Fig. 8d; the aperture 6 is formed by a slant surface);

(y) as in claim 66, the slant surface having a constant angle as determined by a planar orientation is in a (111) plane formed in (100) planed with single crystal silicon (Fig. 8d; constant angle is oriented in xyz direction; fiber optic core is made of a silicon substrate);

(z) as in claim 68, the light introducing part 8 in at least one part is dielectric (Fig. 2e; waveguide 8 is made of dielectric material such as glass);

(aa) as in claim 69, the light introducing part 5 in at least one part is air (Fig. 2e; waveguide 8 includes an air path);

(bb) as in claim 70, the light introducing part in at least one part is an optical fiber (Fig. 2e; waveguide 8 is an optical fiber);

(cc) as in claim 71, the light introducing part in at least one part includes a combination of a core 3 relatively high in refractivity and a clad 4 relatively low in refractivity (Fig. 2e; column 4, lines 16-18);

(dd) as in claim 72, the light introducing part in at least one part has a focusing function to focus light to be propagated to the very small aperture (Fig. 2e;

(ee) as in claim 73, the light introducing part has a vertical surface to a light propagation direction having at least one part made in a convex form (Fig. 8d; 6 has a convex form);

(ff) as in claim 74, the light introducing part in at least one part has a grating structure 30 (Fig. 2d);

(gg) as in claim 76, the taper 6 in at least one part is provided with a focus functioning member having a focusing function to focus light to the very small aperture (Fig. 2e);

(hh) as in claim 77, a focus functioning member having a focusing function to focus light to the very small aperture is

provided in at least one part of an optical path between the light reflection layer and the taper (Fig. 2e);

(ii) as in claim 78, a focus functioning member having a focusing function to focus light to the very small aperture is provided in at least one part of the light reflection layer (Fig. 2e);

(jj) as in claim 79, a focus functioning member having a focusing function to focus light to the very small aperture is provided in at least one part of the light introducing part (Fig. 2e).

(kk) as in claim 80, the focus functioning member in at least on part is dielectric (Fig. 2e);

(ll) as in claim 81, the focus functioning member has a vertical surface extending in a light a light propagation direction , the vertical surface having at least one convex portion (Fig. 2e);

(mm) as in claim 82, the focus functioning member is generally spherical-shaped (Fig. 2e);

(nn) as in claim 84, at least one part of the focus functioning member has a grating structure (Fig. 2e);

(oo) as in claim 85, the very small aperture and the light reflection layer are provided in proximity with (Fig. 2e);

(pp) as in claim 86, a distance between the very small aperture and the light reflection layer is 20 um or less (Figs 3c and 3d);

(qq) as in claim 87, an apertured substrate 2a having the very small aperture 6 is provided on a surface opposed to the recording medium (Figs. 2f and 11);

(rr) as in claim 88, the light reflection layer 10, 30 is laid and formed on an opposite surface forming the very small aperture 6 of the apertured substrate 2a (Figs. 2f and 8a);

(ss) as in claim 89, the light reflection layer 30 is bonded and formed on an opposite surface forming the very small aperture 6 of the apertured substrate 2a (Fig. 2f);

(tt) as in claim 90, the light reflection layer 10/23 is laid and formed in a surface forming the very small aperture of the apertured substrate (Fig. 8(a)to 8(d); layer 10 and 23 is the reflective layer);

(uu) as in claim 91, the light introducing part 8 is laid and formed on an opposite surface forming the very small aperture of the apertured substrate (Fig. 2e);

(vv) as in claim 92, the light introducing part 8 is bonded and formed on an opposite surface forming the very small aperture of the apertured substrate (Fig. 2e);

(ww) as in claim 93, the light introducing part 8 is laid and formed in a surface forming the very small aperture of the apertured substrate (Fig. 2e);

(xx) as in claim 94, the light focus functioning member 23 is laid and formed on an opposite surface forming the very small aperture of the apertured substrate (Fig. 8(a)-8(d));

(yy) as in claim 95, the light focus functioning member 23 is bonded and formed on an opposite surface forming the very small aperture of the apertured substrate (Fig. 8(a)-8(d)); and

(zz) as in claim 114, the very small aperture in plurality of number, and the light introducing part and the light reflection layer being formed to guide light emitted from at least one light source 19 toward a direction of the plurality of very small apertures (Fig. 7b).

12. Claim 96 is rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a manufacturing of a near-field optical head having all the elements and means as cited in claim 96. For example, Muramatsu teaches the following:

(a) as in claim 96, a very small aperture 6 formed at an apex of a taper formed by a light propagation member 2a sharpened at a tip toward a recording medium (Fig. 2f; column 1, lines 20 and 21);

(b) as in claim 96, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2f);

(c) as in claim 96, a light reflection layer 30 for reflecting light propagated through the light introducing part 8 toward the very small aperture 2a (Fig. 2f);

(d) as in claim 96, a focus functioning member 23 provided on an optical path between the light reflection layer 30 and the taper 2a and having a convex form in at least one part of a surface vertical to a direction of light propagation (Fig. 8d); and

(e) as in claim 96, the focus functioning member is formed by working a surface by chemical etching (Fig. 8a-8d; column 5, lines 50-65).

13. Claim 112 is rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a near-field optical head having all the elements and means as cited in claim 112. For example, Muramatsu teaches the following:

(a) as in claim 112, the near field optical head having a very small aperture 6 formed at an apex of a taper 2a formed by a light propagation member sharpened at a tip toward a recording medium (Fig. 2e);

(b) as in claim 112, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e);

(c) as in claim 112, a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Figs. 8a-8d);

(d) as in claim 112, an apertured substrate 23 having a very small aperture on a surface opposed to the recording medium (Figs 8c and 8d; the apertured substrate is the substrate forming the aperture); and

(e) as in claim 112, the very small aperture 6, the light introducing part 8 and the light reflection layer 10 are formed by working a material laid on an opposed surface of the apertured substrate to the recording medium (Figs. 8a-8d).

14. Claim 113 is rejected under 35 U.S.C. § 102(e) as being anticipated by Muramatsu (U.S. Patent 5,969,821).

Muramatsu teaches a near-field optical head having all the elements and means as cited in claim 113. For example, Muramatsu teaches the following:

(a) as in claim 113, the near field optical head has a very small aperture 6 (Fig. 2e);

(b) as in claim 113, forming a slant surface having a constant angle defined by a planar orientation by using chemical reaction (Figs. 8a-8d; taper 2a has a slant surface for forming the aperture);

(c) as in claim 113, forming a light reflection layer 10 by laying a metal on the slant surface (Figs. 8a-8d);

(d) as in claim 113, forming a light introducing part 8 by laying a dielectric on a top surface of the light reflection layer (Figs. 8a-8d; waveguide 8 is a dielectric material such as silicon surrounded by the light reflection layer 10);

(e) as in claim 113, planarize the dielectric layered (Figs. 8a-8d; waveguide 8 is formed by plane surfaces);

(f) as in claim 113, working a part of the dielectric into a taper sharpened toward the recording medium by using chemical reaction (Figs 8a-8d; taper is formed by chemical process such as etching);

(g) as in claim 113, laying a metal film 23 on a top surface of the taper (Fig. 8d); and

(h) as in claim 113, working the metal film at an apex of the taper to thereby form a very small aperture (Fig. 8d).

Claim Rejections - 35 USC § 103

15. The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> *(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.*

16. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohta (U.S. Patent 5,294,790) in view of Harder et al. (U.S. Patent 4,725,727).

Ohta teaches a near-field optical head very similar to that of the present invention. However, Ohta does not teach the following:

(a) as in claim 10, the at least one fine aperture comprises a plurality of fine apertures; and

(b) as in claim 10, the optical waveguide and the light reflection film guide light generated from at least one light source to the plurality of fine apertures.

Harder teaches the following:

(a) at least one fine aperture comprises a plurality of fine apertures 17 and 18 (Fig. 2);

(b) an optical waveguide 13, 15 and the light reflection film 14, 16 guide light generated from at least one light source to the plurality of fine apertures (Figs. 1 and 2; column 2, lines 40-67).

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Ohta's near-field probe, it would have been obvious to one of ordinary skill in the art to add a second aperture such as Harder's on Ohta's aperture means 110, because the original aperture is used for emitting a scanning light beam and the additional aperture is used for the returning of a reflected light beam.

17. Claims 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ohta (U.S. Patent 5,294,790) in view of Harder et al. (U.S. Patent 4,725,727).

Ohta teaches method of manufacturing a near-field optical head very similar to that of the present invention. For example, Ohta teaches the following:

(a) as in claim 15, the near field optical head having a very small aperture 110 for producing or scattering near field light (Fig. 2);

(b) as in claim 15, forming an inverted conical hole 102 penetrating through the planar substrate 101 to have an apex made as a first very small aperture 110 (Fig. 2); and

(c) as in claim 15, forming a light reflection film 109 on a taper 108 of the inverted cone hole 102 (Fig. 2).

However, Ohta does not teach the following:

(a) as in claim 15, forming a second very small aperture;

(b) as in claim 15, the very small aperture having a size defined by a thickness of the light reflection film;

(c) as in claim 15, the very small aperture is smaller than the first very small aperture.

Harder teaches the following;

(a) forming a second very small aperture 17 (Fig. 2);

(b) the very small aperture having a size defined by a thickness of the light reflection film (Fig. 2; column 3, lines 8-20); and

(c) as in claim 15, the very small aperture 17 is smaller than the first very small aperture 18 (Fig. 2).

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Ohta's near-field probe, it would have been obvious to one of ordinary skill in the art to add a second aperture such as Harder's on Ohta's aperture means 110, because the original aperture is used for emitting a scanning light beam and the additional aperture is used for the returning of a reflected light beam.

18. Claims 16 and 17 have limitations similar to those treated in the above rejection, and are met by the references as discussed above and therefore rejected for the same reasons of obviousness as used above.

Claim 16 however also recites the following limitation which is disclosed by Harder on Fig. 2:

(a) as in claim 16, the light reflection film having a partly different thickness on a taper.

Harder's near-field probe is in tapered shape. Hence, to maintain the narrowing form at the aperture end, it would have been obvious to one of ordinary skill in the art to thin the coating film 16 at the tapered end 17 so that the thickness of the film would not over-damped the reflected light beam.

19. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohta (U.S. Patent 5,294,790) in view of Bayer et al. (U.S. Patent 6,088,320) and Harder et al. (U.S. Patent 4,725,727).

Ohta teaches a method of manufacturing a near-field optical head very similar to that of the present invention.

(a) as in claim 18, the near field optical head having a very small aperture 110 for producing or scattering near field light (Fig. 2);

(b) as in claim 18, forming an inverted conical hole 102 penetrating through the planar substrate 101 to have an apex made as a first very small aperture (Fig. 2); and

(c) as in claim 18, forming a film 109 on a taper 108 of the inverted cone hole 102 (Fig. 2).

However, Ohta does not teach the following:

(a) as in claim 18, the film is an oxide film;

(b) as in claim 18, forming a second very small aperture;

(c) as in claim 18, the very small aperture having a size defined by a thickness of the light reflection film; and

(d) as in claim 18, the very small aperture is smaller than the first very small aperture.

Bayer teaches the following:

(a) the taper 4 is coated with an oxide film 6A (Fig. 2; column 4, lines 46).

Harder teaches the following;

(a) forming a second very small aperture 17 (Fig. 2);

(b) the very small aperture having a size defined by a thickness of the light reflection film (Fig. 2; column 3, lines 8-20); and

(c) the very small aperture 17 is smaller than the first very small aperture 18 (Fig. 2).

Thermal oxidation is a semiconductor manufacturing process where a layer of silicon is oxidized. In the case of Ohta's near-field probe, it would have been obvious to one of ordinary skill in the art to use the thermal oxidation process such as Bayer's to manufacture Ohta's near-field probe so that the probe is surrounded with an oxide layer as the result of the manufacturing process.

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Ohta's near-field probe, it would have been obvious to one of ordinary skill in the art to add a second aperture such as Harder's on Ohta's waveguide, because the original aperture is used for emitting a scanning light beam and the additional aperture is used for the returning of a reflected light beam.

20. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohta (U.S. Patent 5,294,790) in view of Kim (U.S. Patent 5,827,100) and Harder et al. (U.S. Patent 4,725,727).

Ohta teaches a method of manufacturing a near-field optical head very similar to that of the present invention.

(a) as in claim 19, the near field optical head having a very small aperture 110 for producing or scattering near field light (Fig. 2); and

(b) as in claim 19, forming an inverted conical hole 102 penetrating through the planar substrate 101 to have an apex made as a first very small aperture (Fig. 2).

However, Ohta does not teach the following:

(a) as in claim 19, performing ion implant to a surface of the substrate;

(b) as in claim 19, forming a second very small aperture;

(c) as in claim 19, the very small aperture having a size defined by a thickness of the light reflection film; and

(d) as in claim 19, the very small aperture is smaller than the first very small aperture.

Kim teaches the following:

(a) a cone-shaped forming a tip on a semiconductor layer by an ion etching method (column 2, lines 10-20).

Harder teaches the following;

(a) forming a second very small aperture 17 (Fig. 2);

(b) the very small aperture having a size defined by a thickness of the light reflection film (Fig. 2; column 3, lines 8-20); and

(c) the very small aperture 17 is smaller than the first very small aperture 18 (Fig. 2).

A typical photoresist semiconductor manufacturing process cannot form a fine tip. In the case of producing a second very small aperture, it would have been obvious to one of ordinary skill in the art to use a ion implant process such as Kim's to form a second tip 17 on Harder's tip 18, because the ion implant process can control the grow of the tip's aperture and its diameter.

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Ohta's near-field probe, it would have been obvious to one of ordinary skill in the art to add a second aperture such as Harder's on Ohta's aperture means 110, because the original aperture is used for emitting a scanning light beam and the additional aperture is used for the returning of a reflected light beam.

21. Claim 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Ohta et al. (U.S. Patent 5,294,790).

Muramatsu teaches a near-field optical head very similar to that of the present invention. However, Muramatsu does not teach the following:

(a) as in claim 34, the taper has at least one part structured by a combination of a plurality of tapers different in angle of apex spread.

Ohta teaches the following:

(a) the taper has at least one part structured by a combination of a plurality of tapers different in angle of apex spread (Figs. 39-42).

Muramatsu's taper 2a can be improved by making its probe 6 smaller while increasing its bonding strength. For example, a very small tip can be formed by several stages of tapers instead of a single conical shape taper. Hence, it would have been obvious to one of ordinary skill in the art to replace Muramatsu's taper 2a with Ohta's multiple stepped tapers, because the plurality of stepped tapers increase mechanical strength of bonding a probe as small as possible.

22. Claims 50 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Shintani et al. (U.S. Patent 5,796,706).

Muramatsu teaches a near-field optical head very similar to that of the present invention. However, Muramatsu does not teach the following:

(a) as in claim 50, the floating force is due to a pressure of a liquid applied in a constant thickness on a surface of the recording medium.

Shintani teaches a near-field optical head 1 floating on a liquid layer (Fig. 2; column 2, lines 5 and 6).

A near-field probe such as Muramatsu's positioned above a rotating recording medium will generates a floating force. On the other hand, Shintani adds a liquid layer as a lubricant between the probe and the medium for the benefit of lubrication. Hence, when there is an advantage of protecting Muramatsu's near-field optical head, it would have been obvious to one of ordinary skill in the art to apply a liquid to the air layer between the probe and the medium, because the liquid layer instead of the air layer provides a damping effect on the flying probe and also cleans the contaminants on the rotating medium.

23. Claims 53-57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Shintani et al. (U.S. Patent 5,796,706).

Muramatsu teaches a near-field optical head very similar to that of the present invention. However, Muramatsu does not teach the following:

(a) as in claim 53, a slider structure in a surface opposed to the recording medium;

(b) as in claim 54. the very small aperture is formed in a slider surface;

(c) as in claim 55, a spacing between the recording medium and the very small aperture is nearly same as a spacing between the recording medium and the slider surface;

(d) as in claim 56, a near field optical head according to claim 53, wherein the taper and the slider structure are provided in proximity with; and

(e) as in claim 57, the slider structure is arranged in a manner surrounding by 180 degrees over a periphery of the taper.

Shintani teaches the following:

(a) a slider structure 3 in a surface opposed to the recording medium 2 (Fig. 1);

(b) the very small aperture 1 is formed in a slider surface 3 (Figs. 6A and 6B); and

(c) a spacing between the recording medium 2 and the very small aperture 1 is nearly same as a spacing between the recording medium and the slider surface (Figs. 6A and 6B);

(d) the taper and the slider structure 3 are provided in proximity with (Figs. 6A and 6b); and

(e) as in claim 57, the slider structure is arranged in a manner surrounding by 180 degrees over a periphery of the taper (6A and 6B).

Although Muramatsu does not mention that his substrate 2 is a slider, he discloses that the substrate is a cantilever (column 2, lines 55). When Muramatsu's optical probe is used as a high-density recording apparatus as he disclosed in column 1, line 20 and 21, it would have been obvious to one of ordinary skill in the art to modify the cantilever 2 to a slider similar to Shintani's, because the slider generates an air bearing which will lift Muramatsu's aperture above the rotating medium for smooth scanning operation.

24. Claims 58 and 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Shintani et al. (U.S. Patent 5,796,706) and Furuichi et al. (U.S. Patent 6,731,462).

Muramatsu in view of Shintani teach a near-field optical head very similar to that of the present invention. However,

both Muramatsu and Shintani do not teach the following:

(a) as in claim 58, the slider structure in at least one part is dielectric; and

(b) as in claim 59, the slider structure in at least one part is metal.

Furuichi teaches the following:

(a) the slider structure 1 in at least one part is dielectric (Fig. 1, column 8, lined 40-44; ceramic has a dielectric property); and

(b) the slider structure 1 in at least one part is metal 3 (Fig. 1, the slider structure includes a suspension made of metal).

A slider such as Shintani requires mechanical strength for holding a near-field head and a suspension device. Within the requirement of different non-magnetic materials, it would have been obvious to one of ordinary skill in the art to make Shintani's slider with a ceramic material such as Furuichi's, because the ceramic is a hard semiconductor material which do not creates electromagnetic field interference.

To support the weight of a slider structure such as Shintani, it would have been obvious to one of ordinary skill in the art to use a metal suspension means such as Furuichi's to support Shintani's slider, because metal has a flexible

property so that it would not limit the floating force created by the slider.

25. Claim 97 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Bennion (U.S. Patent 4,732,599).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 97, a very small aperture formed at an apex of a taper formed by a light propagation member sharpened at a tip toward a recording medium,

(b) as in claim 97, a light introducing part for propagating light generally in a parallel direction with the recording medium,

(c) as in claim 97, a light reflection layer for reflecting light propagated through the light introducing part toward the very small aperture,

(d) as in claim 97, a focus functioning member provided on an optical path between the light reflection layer and the taper and having a convex form in at least one part of a surface vertical to a direction of light propagation,

However, Muramatsu does not teach the following:

(a) as in claim 97, the focus functioning member is formed by exchanging ions from one part of a surface thereof.

Bennion teaches a method of fabricating an optical displacement sensing device by using an ion exchange process (column 2, lines 3-7).

An optical article such as a waveguide or a cantilever made of glass needs to be strengthen by a chemical process such as ion exchange treatment where smaller ions are replaced for larger ions. In such case, it would have been obvious to one of ordinary skill in the art to fabricate a waveguide such as Muramatsu with an ion exchange process such as Bennion's, because the replaced ion on the waveguide's surface increases the waveguide's endurance to mechanical stress.

26. Claims 99 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Tanisawa et al. (U.S. Patent 5,278,929).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 99, the near field optical head 70 having a very small aperture 6 formed at an apex of a taper 2a formed by a light propagation member 8 sharpened at a tip toward a

recording medium (Fig. 2e; the optical head is applied to a medium in close proximity; column 1, lines 55-57);

(b) as in claim 99, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e);

(c) as in claim 99, a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 8(a)-8(d)); and

(d) as in claim 99, a focus functioning member 23 provided on an optical path between the light reflection layer 10 and the taper 2a and having a convex form in at least one part of a surface vertical to a direction of light propagation (Fig. 8(d); focusing member 23 is placed vertical to the direction of light in order to interface with the light beam).

However, Muramatsu does not teach the following:

(a) as in claim 99, the focus functioning member is formed by setting with UV radiation a liquid having a curved surface due to a surface tension.

Tanisawa teaches an optical waveguide where its connection is formed with UV setting (Fig. 3; column 4, lines 64-68, column 5, lines 1 and 2).

To form an additional component on a waveguide, a liquid state material is connected to the waveguide and then hardened by a curing process. In the case of forming a focusing part on

an optical probe, it would have been obvious to one of ordinary skill in the art to using a UV setting process such as Tanisawa's to connect Muramatsu's focusing part 23 having a curved surface in a liquid form to the waveguide 8, because the UV setting process can bind/cure two optical waveguide together so that its coupling efficient is same as a continuous waveguide.

27. Claim 100 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Yao et al. (U.S. Patent 6,159,385).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 100, the near field optical head 70 having a very small aperture 6 formed at an apex of a taper 2a formed by a light propagation member 8 sharpened at a tip toward a recording medium (Fig. 2e; the optical head is applied to a medium in close proximity; column 1, lines 55-57);

(b) as in claim 100, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e);

(c) as in claim 100, a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 8(a)-8(d)); and

(d) as in claim 100, a focus functioning member 23 provided on an optical path between the light reflection layer 10 and the taper 2a and having a convex form in at least one part of a surface vertical to a direction of light propagation (Fig. 8(d); focusing member 23 is placed vertical to the direction of light in order to interface with the light beam).

However, Muramatsu does not teach the following:

(a) as in claim 100, the focus functioning member is formed by thermosetting a liquid having a curved surface due to a surface tension.

Yao teaches an cantilever device where its connection is formed by thermosetting (column 4, lines 38-50).

To form an additional component on a silicon substrate such as an optical waveguide, a liquid state material is connected to the waveguide and then hardened by a thermo processing using an organic adhesive. In the case of forming a focusing part on an optical probe, it would have been obvious to one of ordinary skill in the art to using a thermosetting process such as Yao's to connect Muramatsu's focusing part 23 having a curved surface in a liquid form to the waveguide 8, because the thermosetting process can bind/cure two optical

waveguide together so that they are chemically bonded by cross-linking the waveguide with an organic adhesive.

28. Claim 101 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Yao et al. (U.S. Patent 6,159,385).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 101, the near field optical head 70 having a very small aperture 6 formed at an apex of a taper 2a formed by a light propagation member 8 sharpened at a tip toward a recording medium (Fig. 2e; the optical head is applied to a medium in close proximity; column 1, lines 55-57);

(b) as in claim 101, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e); and

(c) as in claim 101, a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 8(a)-8(d)).

However, Muramatsu does not teach the following:

(a) as in claim 101, the taper is formed by conducting surface working using chemical reaction.

Yao teaches an cantilever having a conducting surface where other devices are formed with chemical reaction (column 4, lines 38-50; silicon substrate is a conducing surface and thermal setting is a chemical reaction).

To form an additional component on a silicon substrate such as an optical probe, a chemical reaction can be used as a bonding process. In the case of forming a taper on an optical cantilever, it would have been obvious to one of ordinary skill in the art to using a chemical reaction such as Yao's to connect Muramatsu's taper 2e to the silicon substrate 2, because the chemical reaction can bind two silicon devices together by cross-linking the silicon substrates with an organic adhesive.

29. Claim 102 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Bednorz et al. (U.S. Patent 4,684,206).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 102, the near field optical head having a very small aperture formed at an apex of a taper formed by a light propagation member sharpened at a tip toward a recording medium (Fig. 2e; the optical head is applied to a medium in close proximity; column 1, lines 55-57);

(b) as in claim 102, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e);

(c) as in claim 102, a light reflection layer 10 for reflecting light propagated through the light introducing part 8 toward the very small aperture 6 (Fig. 2e); and

(d) as in claim 102, a metal 23 covering the taper (Fig. 8d).

However, Muramatsu does not teach the following:

(a) as in claim 102, the very small aperture 6 is formed by plastically deforming the metal in a vicinity of an apex of the taper with using a material harder than the metal.

Bednorz teaches a light probe where the aperture 28 is formed by plastically deforming the metal 6 in a vicinity of an apex of the taper with using a material 16 harder than the metal (Fig. 9; column 40-51).

To form an aperture in a micro-size probe without using any complicated process, it would have been obvious to one of ordinary skill in the art to use a tip deforming method such as Bednorz's to form an aperture in Muramatsu's taper, because the high pressure method creates an opening as an aperture on the taper.

30. Claims 103-105 are rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Bednorz (U.S. Patent 4,684,206).

Muramatsu teaches a method of using a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following steps:

(a) as in claim 103, initialize a near field light produced from a very small aperture (Figs; 2e and 10; column 1, lines 14-16);

(b) as in claim 103, a process of forming in a surface opposed to a recording medium a taper of a dielectric sharpened at a tip toward the recording medium (Fig. 2e; column 1, lines

14-16; substrate 2 is made of quartz which is a dielectric material);

(c) as in claim 103, a tip of the taper to thereby form a very small aperture 6 (Fig. 2e);

(d) as in claim 103, a process of working an opposite surface forming the very small aperture to form a convex form 23 (Fig. 8d; the tip 6 has a convex form);

(e) as in claim 103, a process of bonding onto the convex-worked surface a light introducing part 8 for propagating light generally in a direction parallel with a recording medium and a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 2e and 3d);

However, Muramatsu does not teaches the following:

(a) as in claim 103, a process of laying a metal film on a periphery of the taper; and

(b) as in claim 103, a process of working a metal film at the tip.

Bednorz teaches a method of fabricating a near-field scanning probe 1 having an aperture 28 formed on a taper tip with metal coating 6 (Figs. 3 and 5; column 3, lines 24-39; column 4, lines 48-51).

Although Muramatsu's tip 6 is a waveguide formed with a reflective metal coating, it is not strong enough if the tip

contacts the medium during a near-field scanning operation. To protect the fine point of the near-field scanning tip, it would have been obvious to one of ordinary skill in the art to add a metal coating 6 such as Bednorz's to Muramatsu's tip 6, because the metal coating increase the rigidness of the tip in case of the tip crashes with the medium.

31. Claim 104 has limitations similar to those treated in the above rejection (claim 103), and is met by the references as discussed above. Claim 104 however also recites the following limitation which is taught by the prior art of Muramatsu:

(a) a process of exchanging ions on an opposite surface forming the very small aperture to thereby form a convex form (Fig. 11; column 45-53; atomic force probe 1 injects charges to the medium);

32. Claim 105 has limitations similar to those treated in the above rejection (claim 103), and is met by the references as discussed above. Claim 105 however also recites the following limitations which are taught by the prior art of Muramatsu:

(a) a process of exchanging ions on an opposite surface forming the very small aperture to thereby form a convex form (Fig. 11; column 45-53; atomic force probe 1 injects charges to the medium); and

(b) forming a refractivity gradient on the light introducing part (Fig. 3d; layers 3, 4 and 10 each has its own refractive index).

33. Claim 106 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Tanisawa et al. (U.S. Patent 5,278,929).

Muramatsu teaches a method of using a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following steps:

(a) as in claim 106, initialize a near field light produced from a very small aperture (Figs; 2e and 10; column 1, lines 14-16);

(b) as in claim 106, a process of forming in a surface opposed to a recording medium a taper of a dielectric sharpened at a tip toward the recording medium (Fig. 2e; column 1, lines

14-16; substrate 2 is made of quartz which is a dielectric material);

(c) as in claim 106, a process of laying a metal film 10 on a periphery of the taper (Fig. 8a);

(d) as in claim 106, a process of working a metal film 23 at the tip 6 (Fig. 8d);

(e) as in claim 106, a tip of the taper to thereby form a very small aperture 6 (Fig. 8d);

(f) as in claim 106, a process of working an opposite surface forming the very small aperture to form a convex form 23 (Fig. 8d; the tip 6 has a convex form); and

(g) as in claim 106, a process of bonding onto the convex-worked surface a light introducing part 8 for propagating light generally in a direction parallel with a recording medium and a light reflection layer 10 for reflecting light propagated through the light introducing part toward the very small aperture 6 (Fig. 2e and 3d).

However, Muramatsu does not teaches the following:

(a) as in claim 106, applying a liquid over an opposite surface forming the very small aperture and setting with UV radiation to form a convex form.

Tanisawa teaches an optical waveguide where its connection is formed with UV setting (Fig. 3; column 4, lines 64-68, column 5, lines 1 and 2).

To form an additional component on tip of the taper, a liquid state material can be applied to the taper and then hardened by an UV setting process. For example, to form a focusing part on Muramatsu's optical tip, it would have been obvious to one of ordinary skill in the art to using a UV setting process such as Tanisawa's so that a focusing device 23 in liquid form can be applied to Muramatsu's waveguide tip 8, because the UV setting process can bind/cure the tip and the focusing device 23 together so that its coupling efficient is same as a continuous waveguide.

34. Claim 108 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Harder et al. (U.S. Patent 4,725,727).

Muramatsu teaches a method of using a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following steps:

(a) as in claim 108, a near field light produced from a very small aperture (Figs; 2e and 10; column 1, lines 14-16);

(b) as in claim 108, a process of forming in a surface opposed to a recording medium a taper of a dielectric sharpened at a tip toward the recording medium (Fig. 2e; column 1, lines 14-16; substrate 2 is made of quartz which is a dielectric material);

(c) as in claim 108, laying a metal film 10 on a periphery of the taper (Fig. 8a);

(d) as in claim 108, a process of working a metal film 23 at the tip 6 (Fig. 8d); and

(e) as in claim 108, a tip of the taper to thereby form a very small first aperture 6 (Fig. 8d);

(f) as in claim 108, a process of bonding onto a surface of the dielectric a light introducing part for propagating light generally in a direction parallel with a recording medium and a light reflection layer for reflecting light propagated through the light introducing part toward the very small aperture.

However, Muramatsu does not teaches the following:

(a) as in claim 108, a process of laying a metal film on a periphery of the taper to form a second very small aperture.

Harder teaches a waveguide for an optical near-field probe having a second very small aperture 17 (Fig. 2).

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Muramatsu's near-field probe, it would have been obvious to one of ordinary skill in the art to add a second aperture such as Harder's on Muramatsu's waveguide taper 2a, because the original aperture is used for emitting a scanning

light beam and the additional aperture is used for the returning of a reflected light beam.

35. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muramatsu et al. (U.S. Patent 5,969,821) in view of Tanisawa et al. (U.S. Patent 5,278,929) and Harder et al. (U.S. Patent 4,725,727).

Muramatsu teaches a manufacturing method of a near field optical head very similar to that of the present invention. For example, Muramatsu teaches the following:

(a) as in claim 111, the near field optical head 70 having a very small aperture 6 formed at an apex of a taper 2a formed by a light propagation member 8 sharpened at a tip toward a recording medium (Fig. 2e; the optical head is applied to a medium in close proximity; column 1, lines 55-57);

(b) as in claim 111, laying a metal film 10 on a periphery of the taper (Fig. 8a);

(c) as in claim 111, a process of working a metal film 23 at the tip 6 (Fig. 8d);

(d) as in claim 111, a tip of the taper to thereby form a second very small first aperture 6 having a convex form (Fig. 8d);

(e) as in claim 111, a light introducing part 8 for propagating light generally in a parallel direction with the recording medium (Fig. 2e); and

(f) as in claim 111, the convex form aperture is bonded to the light introducing part (Fig. 8(a)-8(d)).

However, Muramatsu does not teach the following:

(a) as in claim 111, an additional (first) very small aperture is formed at an apex of the tip of the taper; and

(b) as in claim 111, the second very small aperture is formed by setting with UV radiation a liquid to form a convex form.

Harder teaches a waveguide for an optical near-field probe having an additional (first) very small aperture 17 and a second very small aperture 18 (Fig. 2).

Tanisawa teaches the aperture having a convex form is formed with UV setting (Fig. 3; column 4, lines 64-68, column 5, lines 1 and 2).

To detect the reflected light with a near-field scanning probe, the optical probe should provide a returning path. In the case of Muramatsu's near-field probe, it would have been obvious to one of ordinary skill in the art to add an aperture such as Harder's on Muramatsu's waveguide taper 2a, because the original aperture 6 is used for emitting a scanning light beam

and the additional aperture is used for the returning of a reflected light beam.

To mold the tip of a waveguide in a certain form, the waveguide is heat to a liquid state then hardened by a curing process. In the case of forming a convex aperture on an optical probe, it would have been obvious to one of ordinary skill in the art to using a UV setting process such as Tanisawa's to cure Muramatsu's aperture 23 during a liquid form, because the UV setting process can hardened the aperture 23 from a liquid state to a convex form.

Allowable Subject Matter

36. Claims 4, 5, 35, 38, 43, 67, 75 and 83 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

37. Claims 98, 107, 109 and 110 are allowable over prior art.

38. The following is an Examiner's statement of reasons for the indication of allowable subject matter:

As in claim 4, the prior art of record fails to teach or fairly suggest the following feature:

(a) one of the slant surfaces has a degree of slant smaller than a mean degree of slant of the plurality of slant surfaces and is disposed in a vicinity of the fine aperture.

As in claim 5, the prior art of record fails to teach or fairly suggest the following feature:

(a) at least one of the slant surfaces has an angle of inclination smaller than 55 degrees with respect to a surface forming the fine aperture.

As in claim 35, the prior art of record fails to teach or fairly suggest the following features:

(a) the plurality of tapers has, in a vicinity of the very small aperture, a taper having an angle of spread greater than a mean angle of spread of the plurality of tapers.

As in claim 38, the prior art of record fails to teach or fairly suggest the following features:

(a) the taper is asymmetric in shape about a center axis of the taper passing the apex.

As in claim 67, the prior art of record fails to teach or fairly suggest the following features:

(a) the light reflection layer has a reflecting direction of light of approximately 70 degrees with respect to a propagation direction in the light introducing part.

As in claims 75 and 83, the prior art of record fails to teach or fairly suggest the following features:

(a) the light introducing part in at least one part has a gradient of refractivity having a refractivity different stepwise.

As in claim 98, the prior art of record fails to teach or fairly suggest the following features:

(a) a focus functioning member provided on an optical path between the light reflection layer and the taper and having a refractive gradient having a refractivity different stepwise.

As in claims 107 and 110, the prior art of record fails to teach or fairly suggest the following features:

(a) bonding a spherical lens onto an opposite surface forming the second very small aperture; and

(b) bonding onto a surface of the spherical lens a light introducing part for propagating light generally in a direction parallel with a recording medium and a light reflection layer for reflecting light propagated through the light introducing part toward the very small aperture.

As in claim 109, the prior art of record fails to teach or fairly suggest the following features:

(a) a process of bonding a dielectric 1008 having a refractivity gradient different in refractivity onto an opposite surface forming the second very small aperture; and

(b) bonding onto a surface of the dielectric a light introducing part for propagating light generally in a direction parallel with a recording medium and a light reflection layer for reflecting light propagated through the light introducing part toward the very small aperture. The features indicated above, in combination with the other elements of the claims, are not anticipated by, nor made obvious over, the prior art of record.

Conclusion

39. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Cozier et al. (6,441,359) is pertinent because Cozier teaches a near field optical head having a microfabricated solid immersion lens.

Mukasa et al. (6,389,210) is pertinent because Mukasa teaches a scanning probe optical waveguide.

Kasama et al. (6,3376,827) is pertinent because Kasama teaches a near-field optical head having a plurality of apertures.

Payne et al. (6,212,047) is pertinent because Payne teaches a slider having an aperture in the middle.

Macdonald et al. (5,844,251) is pertinent because MacDonald teaches an optical probe having an aperture coated with a metal film.

Inui et al. (5,570,336) is pertinent because Inui teaches a slider and a probe tip.

Ito et al. (5,734,632) is pertinent because Ito teaches an optical probe having an aperture coated with a metal film.

Kino et al. (5,689,480) is pertinent because Kino teaches a near-field optical head having a very small aperture.

Islam (5,664,036) is pertinent because Islam teaches a method of making a fiber optic probe for near-field microscopy.

Koyanagi et al. (5,627,815) is pertinent because Koyanagi teaches a scanning probe microscope.

Kopelman et al. (5,362,963) is pertinent because Kopelman teaches a fiber optic probe having a plurality of apertures.

Buckland (5,410,151) is pertinent because Buckland teaches a fiber optic probe and a core layer and a clad layer.

Sela (5,381,237) is pertinent because Sela teaches an optical waveguide having a gradient index lens on its tip.

40. Any response to this action should be mailed to:

Commissioner of Patents and Trademarks Washington, D.C. 20231 Or faxed to:

(703) 872-9306 (for formal communications intended for entry. Or:

(703) 746-6909, (for informal or draft communications, please label "PROPOSED" or "DRAFT")

Hand-delivered responses should be brought to Crystal Park II, 2021 Crystal Drive, Arlington. VA., Sixth Floor (Receptionist).

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 305-4700.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kim CHU whose telephone number is (703) 305-3032 between 9:30 am to 6:00 pm, Monday to Friday.

KC 5/26/04

Kim-Kwok CHU
Examiner AU2653
May 26, 2004

-(703) 305-3032

William Korzuch

WILLIAM KORZUCH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600